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# Mortgages and Credit Cycle Divergence in Eurozone Economies

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**Abstract**

The dynamics of household mortgage credit and loans to non-financial business have diverged significantly in recent decades. In this paper we construct and describe credit cycles for total bank credit, household mortgages and non-financial business loans for 14 EMU economies over 1990–2013. We explore the cross-country coherence of credit gaps measured by synchronicity of movements and similarity of amplitudes, and analyze correlates of credit cycle coherence. Two findings stand out. As household mortgage credit assumes a larger share in total credit, credit cycle coherence across EMU economies decreases. EMU membership is associated with convergence of business credit cycles but *divergence* of household mortgage credit cycles. These findings survive a battery of sensitivity checks. We discuss implications for monetary policy.

**Keywords:** credit cycles, synchronicity, similarity, EMU

**JEL Classification:** E32; E44; E51; F36

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# 1 Introduction

Business cycles are linked to financial cycles. Growth recoveries are faster if they coincide with an upswing of the financial cycle; recessions last longer if they coincide with a downturn of the financial cycle (Drehmann et al., 2012; IMF, 2012). The aftermath of the 2007 crisis has reminded us that 'balance sheet recessions' (Koo, 2011) or 'debt deflations' (Fisher, 1933) are painfully long stagnations, when firms and households focus on reducing debt rather than maximizing profit or consumption. This has sparked a revival of research and policy interest in the drivers and consequences of credit market conditions. Credit is 'back from the wilderness' (Borio and Lowe, 2004) and the credit (or financial) cycle was rediscovered (Borio, 2014).

And yet research on credit cycles is still scarce. The present paper is the first to (i) construct and describe credit cycles for household mortgages and non-financial business loans for 14 EMU economies over 1990–2013, (ii) construct measures for their coherence, and (iii) analyze correlates of credit cycle coherence. Key findings will be that more household mortgage credit in total credit tends to decrease credit cycle coherence, and that EMU membership is associated with convergence of business credit cycles (in line with convergence of business cycles) but *divergence* of mortgage credit cycles, and therefore total-credit cycles.

The context to this study is one where over the last decades, bank lending, especially in advanced economies, has increased rapidly. Increasingly, credit flows have been towards households, mostly as household mortgage loans. In a balanced panel of 14 countries from 1990 to 2012 Bezemer et al. (2015) find an increase in mortgage loans as percentage of total bank loans from 20% to 50% (see also Jorda et al., 2014). One motivation for our study is that this changing composition of credit has adverse implications for growth and stability. It may also impinge on monetary policy effectiveness, which depends on credit market conditions (Bernanke and Gertler, 1995). This is especially relevant in the context of the single monetary policy in the Eurozone. In the next section we discuss each of these

motivations for the present paper.

We construct credit cycles based on turning points and filters (Drehmann et al., 2012). We do this for total bank credit, for credit to non-financial business and for household mortgage credit. The data show that these are the two most important bank credit categories, jointly accounting for about 75% of the total stock of bank credit in our sample in 2012. We then construct measures for credit cycle coherence following Mink et al. (2012), in terms of synchronicity (do credit cycles move in the same direction?) and similarity (do credit cycle have similar amplitudes?).

We regress these measures in panel models on possible drivers of similarity and synchronicity, with a particular interest in the roles of changing credit composition over time, and of EMU membership. The findings underline the importance of differentiating between credit types in understanding the financial cycle. We discuss how our findings may help understand different impacts of the single monetary policy across EMU economies.

The paper is structured as follows. Section 2 explores linkages between credit cycles, credit composition and monetary union, which motivate this paper. The methodology of constructing credit cycles and synchronicity and similarity measures is described in Section 3. Section 4 discusses trends in the data and key statistics. Section 5 presents the results from the empirical analysis. Section 6 concludes with summary and reflection on the findings and their policy relevance.

# 2 Optimal Currency Areas, Credit Cycles and the Credit Channel of Monetary Policy

## 2.1 Credit Cycles, Optimal Currency Areas and EMU

The theory of optimum currency areas (OCA) (Mundell, 1961) indicates that common-currency benefits are larger if member-states have larger similarity in their macroeconomic shocks and cycles (Frankel and Rose, 1998). This has sparked an exten-

sive literature on business cycles convergence within the European Economic and Monetary Union (EMU), with mixed findings.[1] While some studies find evidence for increased correlation of business cycles within the EMU, particularly after the euro adoption (Crespo-Cuaresma and Fernández-Amador, 2013; Enders et al., 2013; Gächter and Riedl, 2014), others report weak output coherence with no effects of the euro changeover (Giannone et al., 2008; Canova et al., 2012; Mink et al., 2012). Also, EMU business cycles have de-synchronized since the onset of the global financial crisis (Gächter et al., 2012).

The many studies on business cycle convergence are not matched by comparable research interest in financial cycle convergence. A currency union implies financial integration (e.g., Ingram, 1969; Mundell, 1973; Rose and Engel, 2002), but OCA theory is silent on financial optimality conditions. This was criticized by Goodhart (1998), who argues that the neglect in OCA theory of credit leads to the neglect of the sustainability of debt structures and of political underpinnings of a viable currency union. Others argue that OCA theory should include optimality conditions on capital flows and integrated credit markets, in analogy to optimality conditions on labor mobility (Priewe, 2007). Praet (2014) points to the possibility that financial factors may contribute to capital misallocation. Another concern is that the effects of ECB monetary policy on aggregate bank lending are heterogeneous across euro area countries (Angeloni et al., 2002; De Santis and Surico, 2013), particularly during the global financial crisis (Cour-Thimann and Winkler, 2012). There is some evidence to suggest that this may be so because different credit aggregates respond differently to policy shocks (Ciccarelli et al., 2013, 2015).

All this suggests that understanding synchronicity of credit cycles is important to understanding currency area optimality and sustainability, in addition to well-known factors such as capital flows (Lane, 2006), international portfolio diversification (McKinnon, 2002) and integration of financial markets (Baele et al., 2004; Kim

[1] See e.g., De Haan et al. (2008) for a survey of studies on business cycle convergence in EMU.

et al., 2005). A key motivation for including credit conditions in OCA is its theoretical emphasis on the importance of shocks. Credit may amplify or even originate shocks, as in Minsky's 'Financial Instability Hypothesis' (Minsky, 1978) and also in more recent theoretical contributions (Kiyotaki and Moore, 1997; Brunnermeier and Sannikov, 2014; Boissay et al., 2015). Monetary policy shocks may affect bank capital and lending (e.g., Kishan and Opiela, 2000; Stein and Kashyap, 2000; Mishkin, 2001; Ashcraft, 2006). The effects of shocks are intermediated by the interaction of credit and real estate markets. Empirical studies (Black et al., 2010; Jiménez et al., 2012) show that asset market shocks may have real effects through the bank lending channel, by changing banks' balance sheet strength and risk perception (Davis and Zhu, 2009; Disyatat, 2011).

## 2.2 Differentiating Household Mortgages and Business Credit

Mortgages, which connect credit markets and real estate asset markets, take on particular relevance in this context — especially given their abundant growth in recent years. And indeed the dynamics of mortgage credit are pivotal in understanding credit cycle convergence, as we shall find in this paper. This conforms an emerging literature which finds that household loans (especially mortgages) and business loans have fundamentally different impacts on growth (Werner, 1997, 2012; Jappelli et al., 2013; Bezemer, 2014). Empirical research finds that expansion of household mortgage loans depresses economic growth rates (Barba and Pivetti, 2009; Sutherland et al., 2012; Jappelli et al., 2013), increases the probability of a financial crisis (Claessens et al., 2010; Cecchetti et al., 2011) and worsens its consequences in terms of output loss and recession duration (Lane and Milesi-Ferretti, 2011; Berkmen et al., 2012; Babecky et al., 2013; Beck et al., 2014).

For instance, Mian and Sufi (2014) show that U.S. households with more mortgage debt reduced their spending more than others after 2007 (also, Mian and Sufi, 2009; Dynan, 2012). There are also spillover effects via bank balance sheets. Banks

holding more household mortgage loans on their books reduce lending to business more, and firms that borrow from these banks have significantly lower investment (Black et al., 2010; Jiménez et al., 2012; Chakraborty et al., 2014). This suggests that it is helpful to study not just 'the' financial or credit cycle, but different credit cycles, differentiating (at least) between household mortgage credit and credit to non-financial business.

The different growth rates of credit to firms and to households have implications for monetary policy. It is plausible that changes in interest rates affect the demand for household mortgage credit differently from the demand for business credit for investment. If both credit types are developing along similar trends and are driven by similar factors, there is a good case that they will respond similarly to monetary policy, and will be well described in a common credit cycle. But the large divergence in growth rates of household and business credit in recent decades suggests that this is not the case (Angeloni et al., 2002; Ciccarelli et al., 2015). Indeed, 'Credit View' or 'Credit Channel' literature shows that the effectiveness of monetary policies depends on credit market conditions (Bernanke and Gertler, 1995). Credit cycle divergence across EMU economies may be one reason for different policy effects across economies. But while business cycle integration is part and parcel of the theory of optimal currency areas, that theory is silent on credit cycle integration, as early OCA theorists already noted (Ingram, 1969; Mundell, 1973). In this paper we connect credit market conditions – that is, the growth and composition of credit flows – to cross-country credit cycle coherence.

## 2.3 Financial Cycles and Credit Dynamics

How, then, to capture the dynamics of credit and asset markets empirically? This is the domain of research on the financial or credit cycle, defined as systematic variations in credit supply (Borio, 2014). Theoretically, credit cycles have been modeled by e.g., Kiyotaki and Moore (1997) and Boissay et al. (2015). They are commonly

measured as the trend-corrected expansion and contraction in bank credit supply and property prices over time. According to Borio (2014), financial cycles are much longer (around 16 years) and have a larger amplitude than business cycles; their peaks coincide with banking crises; they help to predict financial distress risk; and they are dependent on policy regimes.

Research on the financial cycle also finds that the impact of monetary policy regime on financial and credit cycles varies depending on the credit cycle phase. This complements 'Credit View' literature. It follows that if business cycle integration matters to currency area optimality, so must credit cycle integration. Studies on their interaction find that recessions are more severe when they coincide with a downturn of the financial cycle. Recessions tend to be longer and deeper if they are preceded by financial booms, with rising mortgage loans and house prices, or if they are associated with credit crunches and house price busts in the contraction phase of the financial cycle (Igan et al., 2011; Drehmann et al., 2012; Claessens et al., 2012).[2]

A recent study by Meller and Metiu (2014) is a first attempt to analyze credit cycle co-movement and synchronization. The authors use concordance measures and clustering techniques to study non-financial sector credit cycle synchronization of 14 advanced economies. They group them in two clusters with distinct credit cycles. We build on their contribution by (i) studying synchronicity and similarity of credit cycles in the Euro area, and their possible drivers; and (ii) distinguishing different types of credit cycles, in household mortgages and non-financial business loans. While there is some evidence that both credit markets behave very differently (Jorda et al., 2014; Favara and Imbs, 2015), the present paper is the first to extract mortgage credit cycles as distinct from total-credit cycles.

[2]Another strand studies credit boom and credit bust episodes, rather than the cycle as a whole. One strand analyzes regularities and determinants of credit booms (see e.g., Mendoza and Terrones, 2008; Borio et al., 2011; Calderón and Kubota, 2012; Furceri et al., 2012; Lane and McQuade, 2014). Credit booms are strong predictors of credit busts and financial crises (Mendoza and Terrones, 2008; Schularick and Taylor, 2012; Jorda et al., 2014).

# 3 Data and Methodology

## 3.1 Data

We examine credit cycles in 14 EMU countries over the period 1990–2013 with quarterly data. The choice of the sample period is constrained by data availability on disaggregated credit. We use a recently constructed dataset on domestic bank credit to the private sector, collected from central bank statistics on the consolidated balance sheets of monetary financial institutions. On the asset side of the balance sheet, loans are reported separately as mortgages to households, household consumption credit, credit to non-financial business, and credit to non-bank financial business. Household mortgages and loans to non-financial business are the two principal credit categories. We refer to Bezemer et al. (2015) for a detailed description of the dataset.

## 3.2 Credit cycles construction

Most studies on business cycle fluctuations examine cycles lasting 5 to 32 quarters (up to 8 years). Drehmann et al. (2012) analyze credit and property cycles and compare the behavior of short-term cycles with medium-term cycles between 32 to 120 quarters (8 to 30 years). They find that the volatility of these medium-term credit cycles is larger than of short-term cycles. Also Borio (2014) discusses that a financial cycle lasts about 16 years. Therefore, to capture credit dynamics well, we construct medium-term cycles of three credit series in our analysis.

We observe credit series in real terms (deflated by CPI). After logarithmic transformation, following Drehmann et al. (2012) we apply the band-pass filter of Christiano and Fitzgerald (2003) in order to isolate the component of each credit series that corresponds to a medium-term frequency.[3] As the maximum length of time

[3]Christiano and Fitzgerald (2003) provide an optimal finite sample linear approximation to the 'ideal band-pass filter'. An 'ideal band-pass filter' (i.e. in a theoretical setting with unlimited observations) removes all fluctuations outside the pass band, leaves fluctuations inside the pass band

series observations in our sample is 24 years, we select frequencies between 32 to 96 quarters.

### 3.3 Measuring synchronicity and similarity of credit cycles

In constructing measures for coherence of credit cycles, we borrow techniques from the business cycle literature. Gächter et al. (2012) notes two dimensions of cycle coherence: correlation coefficients indicate whether business cycles move in the same direction, while dispersion indices measures differences in the size of output gaps between cycles. Using a single measure does not fully capture coherence of cycles. In this paper, we follow the methodology proposed by Mink et al. (2012), initially developed for business cycles analysis, to measure *synchronicity* in movements of cycles and *similarity* of their amplitudes.

Let $c_i(t)$ denote the credit gap of country $i$ in period $t$, where the credit gap is the deviation of the log of credit from its trend (that is, its cyclical component). $c_r(t)$ is the EMU reference credit gap at time $t$, calculated as the median credit gap for all EMU countries in the sample.[4] Synchronicity between the credit cycle of country $i$ and the EMU reference credit cycle at time $t$ is defined as the product of the country $i$ and EMU credit gaps, scaled by the absolute value of this product:

$$\eta_i(t) = \frac{c_i(t)c_r(t)}{|c_i(t)c_r(t)|}. \tag{1}$$

The synchronicity variable indicates that the credit cycle of country $i$ moves in the same (1) or opposite (-1) direction as the EMU reference cycle. For purposes of description, EMU-wide synchronicity of $n$ countries is calculated as the average of individual synchronicity measures:

unaltered, and does not affect series in any other way. Compared to the commonly used Hodrick and Prescott (1997) filter, the Christiano and Fitzgerald filter has the advantage of extracting medium-term components from series by specifying the frequency range of interest. It also computes cyclical components for all observations, including those at the beginning and at the end of the data series.

[4]Using the median for calculating the EMU reference maximizes synchronicity and similarity measures (Mink et al., 2012).

$$\eta(t) = \frac{1}{n} \sum_{i=1}^{n} \frac{c_i(t) c_r(t)}{|c_i(t) c_r(t)|}. \tag{2}$$

It is defined on a scale $[0,1]$. Credit cycles in all countries may be fully synchronized with the EMU reference cycle (value 1). Value 0 indicates that half of countries in the analyzed sample have credit cycles moving in the same directions, and the other half in the opposite direction.

We then define credit cycle *similarity* as the difference in credit cycle amplitude between country $i$ credit gap and the EMU reference credit gap:

$$\theta_i(t) = 1 - \frac{|c_i(t) - c_r(t)|}{\frac{1}{n} \sum_{i=1}^{n} |c_i(t)|}. \tag{3}$$

Similarity is defined on a scale $[1-n,1]$, where value 1 indicates that both credit cycles have identical amplitudes and are perfectly synchronized. Similarly to synchronicity, EMU-wide similarity of the $n$ EMU countries is defined as:

$$\theta(t) = 1 - \frac{\sum_{i=1}^{n} |c_i(t) - c_r(t)|}{\sum_{i=1}^{n} |c_i(t)|}. \tag{4}$$

EMU-wide similarity takes values from 0 to 1, with higher values indicating more similar amplitudes of credit cycles with the EMU reference cycle.

Below we explore synchronicity and similarity of total-credit cycles and of cycles for the two credit aggregates. In Section 5 we study their correlates.

# 4 Stylized Facts

## 4.1 Credit cycles in the EMU

Figure 1 shows credit cycles for total, mortgage and non-financial business credit for each of EMU economies and the EMU reference cycles over 1990–2013. Most countries experienced credit booms between 2003 and 2007, followed by a credit crunch during the global financial crisis. Although the timing of credit cycle phases

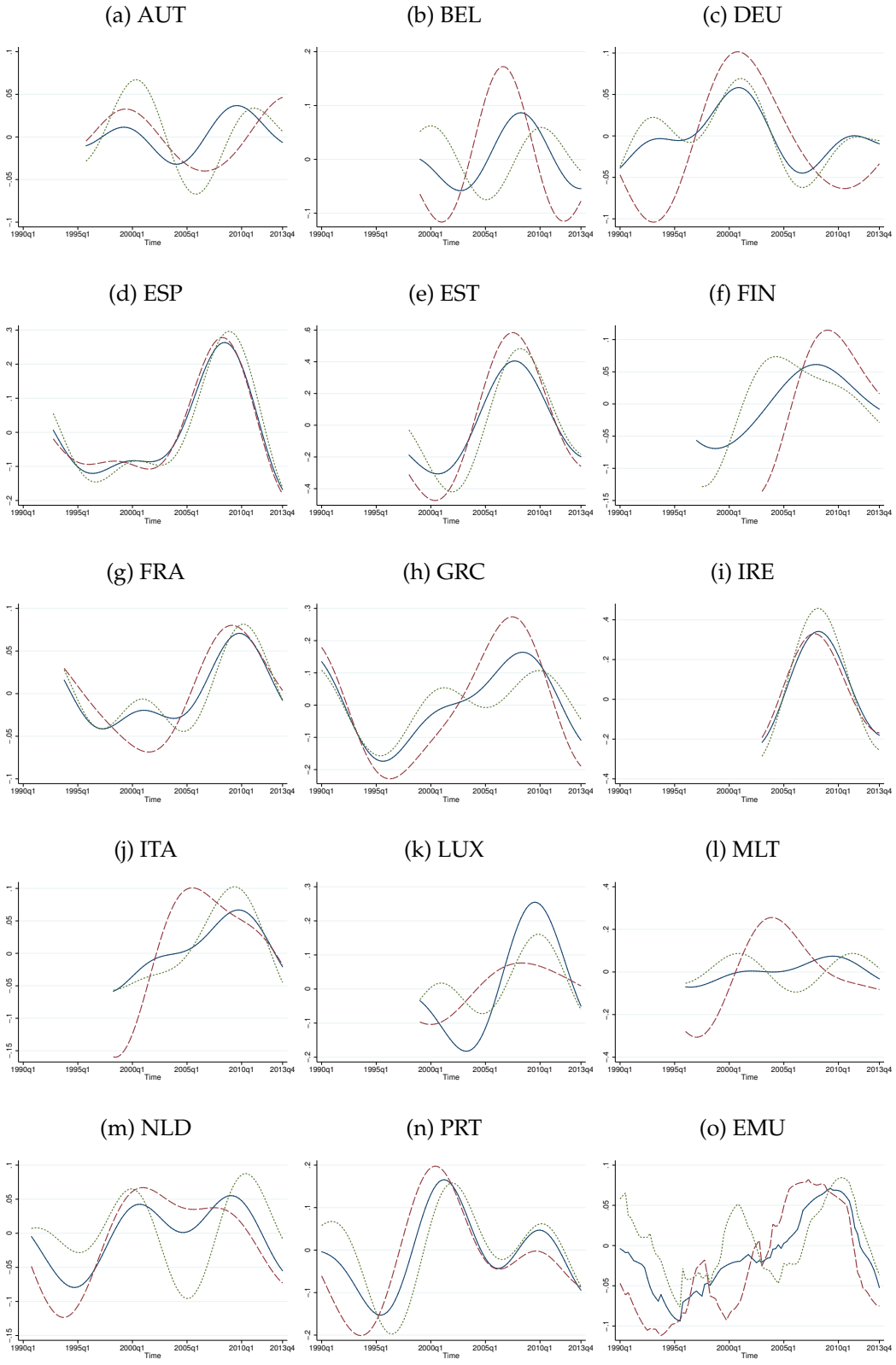
was rather similar, amplitudes differ substantially from country to country across the Euro area. This is linked to the asymmetry of responses of bank credit in each country to common monetary policy shocks (Angeloni et al., 2002; De Santis and Surico, 2013).

There are clear differences between countries' total and disaggregated credit cycles in terms of their magnitudes and fluctuations. In Belgium, the Netherlands and Greece, mortgage credit cycles have a bigger amplitude but the same direction as the total cycle, while non-financial business credit cycles move in the opposite direction. Malta and Italy also stand out as countries where mortgage credit booms are mirrored by a large decline in non-financial business lending. The EMU reference cycles follow similar pattern. Germany and Finland have mortgage cycles with larger amplitudes than non-financial business credit cycle. This observation is in line with previous studies showing that credit booms in advanced countries were caused mainly by the expansion of mortgage lending to households (Bezemer et al., 2015; Jorda et al., 2014). All types of credit cycles co-move closely to each other in most countries in the Eurozone periphery (Spain, Estonia, Ireland, Portugal). Several core EMU economies had clearly dissimilar credit cycles in terms of their amplitudes.

## 4.2 Credit cycle synchronicity and similarity across countries

We proceed to examine synchronicity and similarity of national credit cycles with the EMU reference cycle. Table 1 and Figure A.1 (in the Appendix) show means of synchronicity and similarity over 1990–2013 of (1) total, (2) non-financial business, and (3) mortgage credit cycles across countries. In Table 1 we additionally report tests for the difference in means of synchronicity/similarity between non-financial business credit cycle and total cycle, and between mortgage credit cycle and total cycle. For almost all countries, differences in amplitudes ('similarity') of both cycles

Figure 1: Credit cycles in EMU economies




*Notes:* Based on authors' calculations. Solid lines show total credit cycles, dashed lines — mortgage credit cycles, and dotted lines — non-financial business credit cycles.

with the total-credit cycle are statistically significant. This supports the study of separate cycles.

Table 1: **Synchronicity and similarity of credit cycles**

| | Synchronicity | | | Similarity | | |
|---|---|---|---|---|---|---|
| | Total credit cycle | Non-fin. bus. credit cycle | Mortgage cycle | Total credit cycle | Non-fin. bus. credit cycle | Mortgage cycle |
| Austria | 0.233 | 0.342 | −0.726*** | 0.523 | 0.504 | 0.248*** |
| Belgium | 0.833 | 0.800 | 0.667 | 0.593 | 0.689 | 0.348*** |
| Germany | −0.167 | −0.104 | 0.000*** | 0.206 | 0.333*** | 0.333*** |
| Spain | 0.953 | 0.435*** | 0.882 | 0.005 | −0.247*** | 0.341*** |
| Estonia | 0.906 | 0.250*** | 0.906 | −1.714 | −1.938 | −1.442*** |
| Finland | 0.735 | 0.152*** | 0.227*** | 0.665 | 0.145*** | 0.093*** |
| France | 0.630 | 0.531 | 0.358*** | 0.639 | 0.718** | 0.480*** |
| Greece | 0.583 | 0.667 | 0.708** | 0.115 | 0.379*** | 0.010*** |
| Ireland | 0.909 | 0.409*** | 0.864 | −0.892 | −1.593*** | −0.113*** |
| Italy | 0.778 | 0.365*** | 0.619* | 0.797 | 0.581*** | 0.576*** |
| Luxemburg | 0.633 | 0.867* | 0.567 | −0.748 | 0.573*** | 0.605*** |
| Malta | 0.528 | 0.417 | 0.417 | 0.831 | 0.366*** | −0.336*** |
| Netherlands | 0.441 | 0.634* | 0.462 | 0.667 | 0.535** | 0.619** |
| Portugal | 0.229 | 0.625*** | −0.104*** | 0.102 | 0.095 | 0.161 |
| EMU-wide | 0.547 | 0.453*** | 0.390*** | 0.203 | 0.151*** | 0.205 |

*Notes:* The Table reports means of individual and EMU-wide synchronicity and similarity over the period 1990–2013. ***p<0.01, **p<0.05, *p<0.1, p-values indicate that the mean difference of synchronicity/similarity between types of credit cycles is statistically significant on 1%, 5%, or 10% level, respectively. The null hypothesis of a two-sided mean comparison *t*-test is that the mean difference is zero: $H_0$: *mean (synchronicity/similarity of cycle A) – mean (synchronicity/similarity of cycle B)*$= 0$. The alternative hypothesis is that the mean difference is not zero.

We find low synchronicity for non-financial business credit cycles, while mortgage cycles have been more synchronous in 6 countries. The latter could be explained by the global housing boom in the 2000s, preceding the global financial crisis (see e.g., Dokko et al., 2011; Jorda et al., 2014). The mean of EMU-wide similarity is rather low for all types of credit cycles, suggesting that amplitudes of all types of credit cycles are dissimilar across the Euro area.

We observe large variation between countries in how coherent credit cycles are with the EMU reference cycle. Total-credit cycles in Spain, Estonia, and Ireland are most synchronized with the EMU cycle, while Austria, Germany, and Portugal have the lowest synchronicity values in the sample. At least one of their cycles is moving in opposite direction to the EMU reference cycle. Cycles in EMU core economies are

less synchronized with the EMU cycle than in EMU periphery economies. These observations support Praet (2014) who argues that financial cycles of individual countries within the Euro area are still very heterogeneous.

Notably, synchronicity need not imply similarity. For instance, in Spain and Ireland total credit cycles move quite synchronously with the EMU reference cycle, but have different credit amplitudes. And vice versa, the Austrian mortgage credit cycle moves in the opposite direction but with a relatively similar amplitude to the EMU reference cycle. In the analysis we will distinguish between credit cycle similarity with and without credit cycle synchronicity.

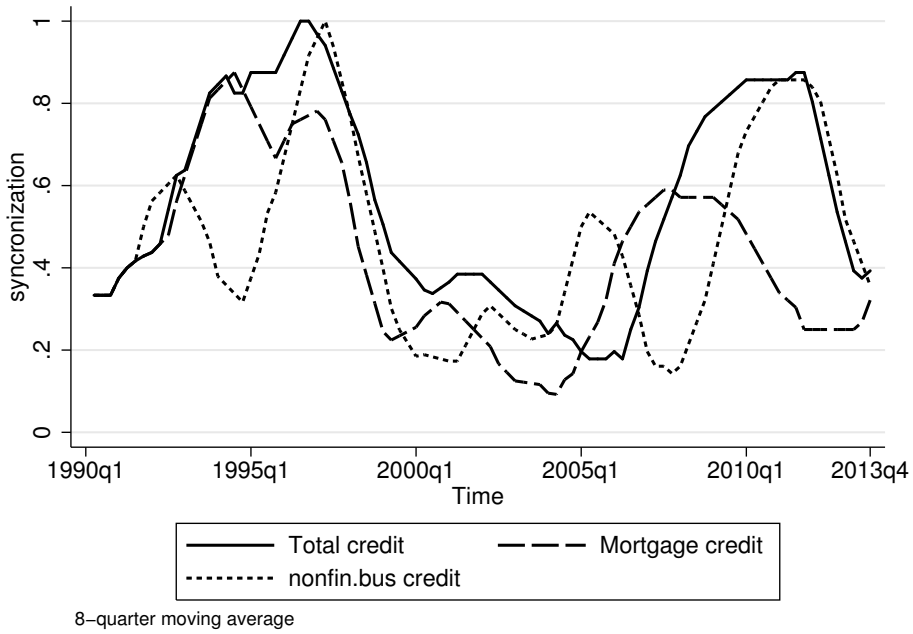
## 4.3 Synchronicity and similarity of credit cycles over time

We study EMU-wide synchronicity and similarity of total-credit and differentiated credit cycles over time in Figure 2. All credit cycles in the EMU became more synchronized over 1990–1996, with EMU-wide synchronicity of total and business credit cycles reaching its maximum value of 1 around 1996. This coincided with an increase also in the similarity measure across the Euro area. In contrast, the two years before and several years after euro creation saw a substantial decline in synchronicity and similarity. We test the possible association of the EMU membership with reduced credit cycle coherence in the next section.

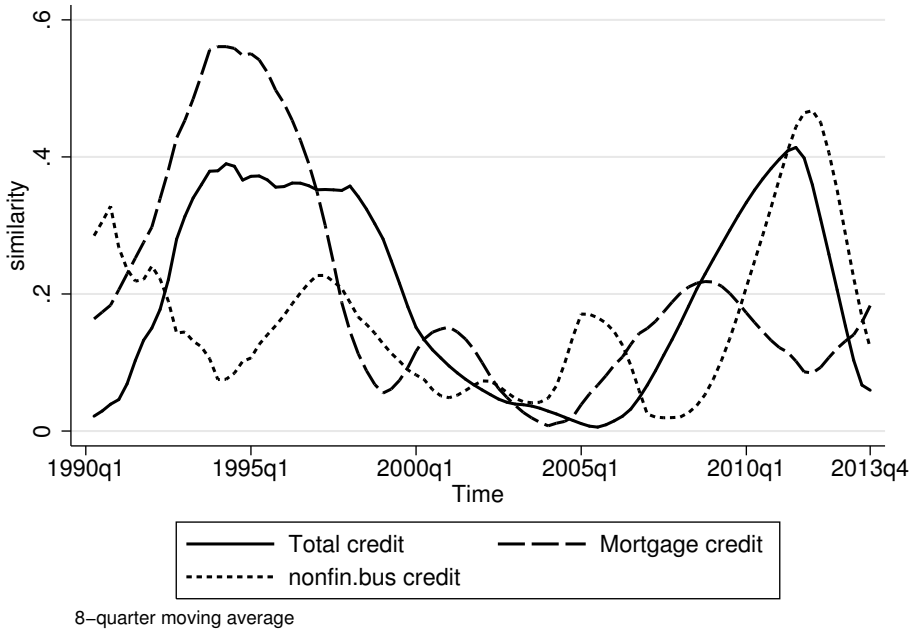
The second wave of increases in EMU-wide synchronicity and similarity occurred during the period 2005–2012. It was associated with the run-up to and unfolding of the global financial crisis and the European sovereign debt crisis. Credit cycles co-moved closely during the 2005–2007 credit boom. In the aftermath of the 2008 credit bust and debt crisis, all credit cycles started diverging from the EMU reference cycle.

Figure 2: EMU-wide synchronicity and similarity of credit cycles

(a) Overall Synchronicity




(b) Overall Similarity



## 4.4 Synchronicity and similarity of credit cycles: pre- and post-EMU comparison

In Table 2 we report means of individual and EMU-wide synchronicity and similarity in the pre- and post-EMU periods, and test for differences in means. To control for the impact of financial crisis years, the 'post-EMU (07)' period runs till the end of 2007, and the 'post-EMU (13)' till the end of 2013.

The mean comparison tests show that credit cycles in the Euro area have become both more de-synchronized and more dissimilar after euro adoption, for all types of credit and for both post-EMU periods. Large de-synchronization in the post-EMU period is observed for mortgage and non-financial business credit cycles. In particular, Germany, The Netherlands and Portugal experienced a significant and substantial divergence of total and mortgage cycles from the EMU reference cycle after euro introduction. This is also true for non-financial business credit cycles in Finland, Spain, Greece, Italy, and Portugal.

The direction of change in similarity varies: credit gaps in some countries became more similar in amplitudes (e.g., Austria, France, Finland, Greece), while their dispersion broadened in other member-states (e.g., Spain, Germany, The Netherlands, Portugal). Germany, The Netherlands, and Portugal exhibit consistent patterns: their credit cycles became less synchronized and less similar with the EMU reference cycles after euro creation.

These explorations show that more synchronous credit cycles can be quite dissimilar, confirming that these are indeed different dimensions of credit cycle coherence. Total and disaggregated credit cycles differ significantly on both dimensions and this supports their separate analysis. That is, even if a total-credit cycle of a country is more synchronous and/or similar to the EMU reference total-credit cycle, this need not hold for mortgage and non-financial business credit cycles. Also, credit cycles became both less synchronous and similar after euro adoption.

Table 2: Synchronicity and similarity: before and after EMU

**Panel A: Synchronicity**

| Country | total credit cycle | | | non-financial business credit cycle | | | mortgage credit cycle | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pre-EMU | Post-EMU (07) | Post-EMU (13) | Pre-EMU | Post-EMU (07) | Post-EMU (13) | Pre-EMU | Post-EMU (07) | Post-EMU (13) |
| Austria | −0.077 | 0.111 | 0.300 | −0.077 | 0.500* | 0.433* | −0.692 | −0.722 | −0.733 |
| Belgium | | 0.833 | 0.833 | | 0.667 | 0.800 | | 0.833 | 0.667 |
| Germany | 0.500 | −0.833*** | −0.567*** | −0.167 | 0.333** | −0.067 | 0.556 | −0.444*** | −0.333*** |
| Spain | 0.920 | 0.944 | 0.967 | 0.840 | −0.056*** | 0.267*** | 1.000 | 0.778** | 0.833** |
| Estonia | 0.900 | | 0.833 | 0.000 | | 0.333 | 0.900 | | 0.833 |
| Finland | 1.000 | 0.778 | 0.700 | 1.000 | −0.389*** | 0.067*** | | 0.300 | 0.227 |
| France | 0.714 | 0.667 | 0.600 | 0.619 | 0.333 | 0.500 | 0.238 | 0.556 | 0.400 |
| Greece | 0.591 | 0.214* | 0.577 | 0.773 | 0.214*** | 0.577 | 0.545 | 0.714 | 0.846** |
| Ireland | | 0.900 | 0.909 | | 0.200 | 0.409 | | 0.700 | 0.864 |
| Italy | 1.000 | 0.889 | 0.767 | 1.000 | −0.056*** | 0.333*** | 1.000 | 0.722 | 0.600 |
| Luxemburg | | 0.667 | 0.633 | | 0.778 | 0.867 | | 0.833 | 0.567 |
| Malta | 0.417 | | 0.750* | 0.417 | | 0.417 | 0.542 | | 0.167* |
| Netherlands | 0.818 | −0.278*** | 0.233*** | 0.515 | 0.667 | 0.700 | 0.758 | 0.000*** | 0.300*** |
| Portugal | 0.889 | −0.889*** | −0.167*** | 1.000 | 0.167*** | 0.400*** | 0.611 | −0.778*** | −0.533*** |
| EMU-wide | 0.612 | 0.361*** | 0.515*** | 0.479 | 0.277*** | 0.437*** | 0.499 | 0.337*** | 0.345*** |

**Panel B: Similarity**

| | total credit cycle | | | nonfin.bus. credit cycle | | | mortgage credit cycle | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pre-EMU | Post-EMU (07) | Post-EMU (13) | Pre-EMU | Post-EMU (07) | Post-EMU (13) | Pre-EMU | Post-EMU (07) | Post-EMU (13) |
| Austria | 0.128 | 0.595*** | 0.609*** | 0.339 | 0.543* | 0.539 | 0.371 | 0.322 | 0.221** |
| Belgium | | 0.603 | 0.593 | | 0.604 | 0.689 | | 0.527 | 0.348 |
| Germany | 0.148 | 0.141 | 0.241 | 0.217 | 0.467*** | 0.402*** | 0.736 | 0.095*** | 0.091*** |
| Spain | 0.367 | −0.076*** | −0.145*** | −0.014 | −0.303** | −0.344** | 0.618 | 0.444** | 0.226*** |
| Estonia | −1.903 | | −0.893*** | −2.221 | | −0.706*** | −1.716 | | −0.254*** |
| Finland | 0.768 | 0.613* | 0.651 | −0.395 | −0.070*** | 0.199*** | | 0.130 | 0.093 |
| France | 0.450 | 0.771*** | 0.705*** | 0.624 | 0.731 | 0.751 | 0.408 | 0.602* | 0.505 |
| Greece | −0.070 | 0.142 | 0.272** | 0.032 | 0.602*** | 0.673*** | −0.123 | 0.094 | 0.122 |
| Ireland | | −1.203 | −0.892 | | −1.601 | −1.593 | | −0.215 | −0.113 |
| Italy | 0.803 | 0.866 | 0.797 | 0.679 | 0.395 | 0.576 | 0.271 | 0.635*** | 0.592*** |
| Luxemburg | | −0.721 | −0.748 | | 0.674 | 0.573 | | 0.746 | 0.605 |
| Malta | 0.860 | | 0.774 | 0.375 | | 0.348 | −0.691 | | 0.372*** |
| Netherlands | 0.741 | 0.527*** | 0.626** | 0.478 | 0.458 | 0.566 | 0.856 | 0.367*** | 0.489*** |
| Portugal | 0.432 | −0.535*** | −0.096*** | −0.190 | 0.050 | 0.266*** | 0.367 | −0.281*** | 0.038*** |
| EMU-wide | 0.267 | 0.070*** | 0.150*** | 0.151 | 0.067*** | 0.149 | 0.306 | 0.108*** | 0.127*** |

*Notes:* The Table reports means of individual and EMU-wide synchronicity and similarity in pre- and post-EMU periods. Pre-EMU period is from 1990q1 (or first available date) until the last quarter before the euro adoption. Post-EMU (07) period is from the euro adoption date until 2007q4; Post-EMU (2013) — until 2013q4. ***p<0.01, **p<0.05, *p<0.1, p-values indicate that the mean difference of synchronicity/similarity between pre- and post-EMU periods is statistically significant on 1%, 5%, or 10% level, respectively. We compare means using a two-sided mean comparison $t$-test, where the null hypothesis is that the mean difference of variables in pre- and post-EMU periods is zero. The alternative hypothesis is that the mean difference is not zero.

# 5 Analysis: Correlates of credit cycle coherence

## 5.1 Data and methodology

This section explores possible drivers of credit cycle coherence. We will conduct panel regression analysis of our measures for synchronicity and similarity. It is important to emphasize that a strictly causal interpretation of these results is problematic. Rather than confidently pointing to 'drivers' of credit cycle coherence, we will be identifying correlates of credit cycle coherence. These results are a first step, to be combined with other data and analysis beyond the scope of this paper, to identify any causal mechanisms. Given the literature and data exploration results, the analysis focuses on two potential correlates of credit cycle coherence: (1) changing composition of credit and (2) EMU membership.

We introduce a number of domestic factors and events as control variables. This is a challenge, given the lack of literature to build on. Therefore, we follow studies on business cycles synchronization and on credit booms to select covariates. We refer to the literature discussion for their motivation. The description of variables and their data sources are presented in Table A.1 in the Appendix.

Domestic factors include countries' macroeconomic, financial, and institutional characteristics. Given that synchronicity and similarity are constructed relative to the EMU reference cycle, we also include some explanatory variables as ratios to the EMU median. These variables are constructed as: $X_{it} = \frac{Z_{it}}{Z_{rt}}$, where $Z_{it}$ is the value of a variable for country $i$ in year $t$ and $Z_{rt}$ is the median of this variable for all EMU countries in the sample. Variables measured in relative terms include: mortgage share (the share of mortgage credit in total bank credit), net capital flows, real stock price change, real house price change, long-term interest rate,[5] trade openness, and income growth.

[5]Alternatively, we include short-term interest rate measured by a three-month money market rate. This did not change the estimation results. Short-term rates in the EMU have converged and do not have an effect on credit cycle coherence. Meanwhile for long-term rates we can still observe between-countries differences; therefore, it is more sensible to include them in the analysis.

We have no strong priors, but the literature leads us to expect that mortgage shares in total credit will be negatively associated with credit cycle coherence. The literature also shows (Imbs, 2004; Inklaar et al., 2008) that trade openness, financial integration, and capital flows increase business cycle synchronization, which may also hold for cycles in credit to non-financial business. We expect that higher capital flows, rising stock and house prices, and higher interest rates relative to EMU median will increase a country's credit cycle coherence with the EMU reference cycle.

We include two domestic institutional factors: capital account liberalization and credit market deregulation. Figure 2 shows that credit cycles across the EMU became more synchronized and similar in the 1990s, when most countries liberalized their capital accounts in preparation for EMU accession. More deregulated credit markets have higher credit growth (Lane and McQuade, 2014) which could make credit cycles more synchronized during the credit boom phase.

Further, we include binary variables for EMU membership and the 2008–2013 financial crisis years. Frankel and Rose (1998) argue that economies become more synchronized after joining the EMU, not before. But this need not imply greater credit cycle synchronization, as EMU membership may drive cycles apart through the following channels. EMU creation implied free capital mobility and no exchange rate risk, which intensified capital flows between member-states. These flows were unevenly distributed across the Euro area – current account deficit, EMU periphery economies were the main receivers of foreign capital, while surplus economies experienced large outflows. Given low investment risk and high EMU credibility, investors could allocate their funds in periphery countries offering higher returns. This caused credit booms in some countries but not in others and may have contributed to credit cycles divergence across EMU.

Lastly, we control for global credit volatility, proxied by the VIX index.

Descriptive statistics are reported in Table A.2 in the Appendix. Correlation analysis suggests that explanatory variables are not highly correlated with each

other. To check for stationarity of the variables, we apply panel unit-root tests. We use Fisher-type tests (both ADF and PP tests) which allow for unbalanced panels. Since only two variables (mortgage share and interest rate) turn out to be non-stationary, this should not be a serious concern for the estimation. Correlation analysis and panel unit-root tests are available on request.

The analysis is conducted on annual data over 1990–2013. The baseline model specification is the following:

$$Y_{it} = \alpha + \beta X_{it} + \kappa IN_{it} + \gamma D_{it} + \psi GL_t + \mu_i + \epsilon_{it}, \;\; i = 1,...,N; t = 1,...,T, \qquad (5)$$

where $Y_{it}$ is credit cycle synchronicity/similarity of country $i$ in year $t$; $X_{it}$ is a matrix of domestic factors constructed in relative terms; $IN_{it}$ are institutional factors; $D_{it}$ are dummy variables for EMU membership and financial crisis; and $GL_t$ is a global volatility factor; $\mu_i$ are unobserved country-specific fixed effects; $\epsilon_{it}$ is a white noise error term with mean 0.

Annual synchronicity and similarity are calculated as averages over four quarters of a year. We estimate panel regressions with country fixed effects and use robust standard errors clustered on a country level.[6]

## 5.2 Estimation results

With total credit plus two credit aggregates and two measures for credit cycle coherence, we need to restrict and focus the analysis. This focus is guided by the research questions: was EMU membership associated with decreasing or increasing credit cycle coherence, and were changes in total-credit cycle associated with

[6]Since synchronicity takes quarterly values -1 or +1, annual synchronicity can take five values (-1, -0.5, 0, +0.5, +1), in increasing order of synchronicity. This suggests that ordered probit might be a better fit. The distribution of similarity is continuous with an upper bound of +1. As a robustness check, we estimate ordered probit for synchronicity and tobit for similarity measures. In both models we include country dummies to control for fixed effects. Applying these models yields qualitatively similar results (available on request). However, including country dummies may result in inconsistent estimates for ordered probit/tobit when the number of observations within each group is small. Therefore, we focus on fixed-effects regressions for continuous dependent variable.

changes in credit composition? We also recognize that similarity of synchronous cycles will have different correlates than similarity of dis-synchronous cycles. In order to organize presentation of results, in this section we present three tables: for synchronicity and similarity of total and differentiated credit cycles, and for similarity conditional on positive synchronicity. To isolate the effect of the financial crisis years, we conduct estimations separately for 1990–2013 and 1990–2007.

Table 3: **Synchronicity of total credit and differentiated credit cycles**

| | 1990–2013 | | | 1990–2007 | | |
|---|---|---|---|---|---|---|
| | total | non-fin.bus. | mortgage | total | non-fin.bus. | mortgage |
| Mortgage share | −2.284 *** | | | −2.727 *** | | |
| | (0.715) | | | (0.900) | | |
| Net capital flows | −0.002 | 0.001 | 0.001 | −0.004 | 0.001 | 0.001 |
| | (0.004) | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) |
| Real stock price change | 0.0005 | 0.003 | −0.017 | 0.032 | 0.009 | 0.026 |
| | (0.020) | (0.036) | (0.026) | (0.029) | (0.040) | (0.040) |
| Real house price change | −0.0001 | −0.0001 | −0.0002 | 0.033 | −0.007 | 0.038 |
| | (0.0003) | (0.0003) | (0.0003) | (0.023) | (0.040) | (0.035) |
| Long-term interest rate | 0.102 | 0.085 | 0.163 | 0.708 ** | 0.658 | 0.653 |
| | (0.070) | (0.066) | (0.118) | (0.329) | (0.563) | (0.483) |
| Trade openness | 0.341 | −0.239 | 0.058 | 0.779 | 0.311 | 0.375 |
| | (0.508) | (0.434) | (0.534) | (0.664) | (0.585) | (0.609) |
| Income growth | −0.018 | 0.013 | −0.015 | −0.028 | −0.027 | −0.025 |
| | (0.011) | (0.019) | (0.015) | (0.019) | (0.023) | (0.035) |
| Capital account liberalization | 0.539 *** | −0.095 | 0.200 * | 0.657 *** | 0.024 | 0.332 *** |
| | (0.139) | (0.058) | (0.100) | (0.111) | (0.110) | (0.088) |
| Credit market deregulation | 0.114 | −0.099 | 0.118 | 0.258 *** | −0.117 | 0.228 ** |
| | (0.089) | (0.092) | (0.113) | (0.079) | (0.159) | (0.092) |
| EMU membership | −0.677 ** | −0.238 | −0.633 ** | −0.835 *** | −0.021 | −0.726 *** |
| | (0.228) | (0.210) | (0.253) | (0.228) | (0.241) | (0.225) |
| Financial crisis | 0.316 | 0.323 * | 0.107 | | | |
| | (0.190) | (0.177) | (0.212) | | | |
| VIX | 0.003 | −0.001 | −0.004 | −0.0004 | −0.008 | −0.023 |
| | (0.007) | (0.006) | (0.010) | (0.012) | (0.011) | (0.015) |
| Observations | 233 | 238 | 232 | 151 | 156 | 150 |
| Log-likelihood | −221.8 | −259.9 | −241.1 | −132.3 | −174.7 | −149.8 |
| R-squared | 0.25 | 0.08 | 0.09 | 0.40 | 0.08 | 0.20 |

*Notes:* The dependent variable is synchronicity of total credit, non-financial business credit, and household mortgage credit cycles. The Table reports coefficient estimates with robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Constant and country-fixed effects are included in the estimations (not shown).

Table 3 presents the estimation results for synchronicity. In total-credit equation, the coefficient estimate for the relative mortgage share is strongly significant with a negative sign in both periods. This suggests that the more total credit cycles are dominated by household mortgages, the less synchronous they are.

Further, we find that EMU membership is negatively associated with synchronization, significantly for total-credit cycles and mortgage credit cycles. In contrast,

cycles of credit to non-financial business did not start moving less synchronously after EMU accession. The EMU effect is not a market liberalization effect. Controlling for EMU membership, more domestic credit market deregulation and larger capital account liberalization are associated with *larger* credit cycle synchronicity. Additionally, higher long-term interest rates lead to more synchronous total credit cycles in the pre-crisis period.

Table 4: **Similarity of total credit and differentiated credit cycles**

| | 1990–2013 | | | 1990–2007 | | |
|---|---|---|---|---|---|---|
| | total | non-fin.bus. | mortgage | total | non-fin.bus. | mortgage |
| Mortgage share | −1.035 | | | −2.038 ** | | |
| | (0.688) | | | (0.712) | | |
| Net capital flows | 0.002 * | −0.002 | 0.001 | 0.002 ** | −0.003 * | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Real stock price change | 0.044 *** | 0.016 | −0.006 | 0.057 * | 0.006 | 0.027 |
| | (0.013) | (0.033) | (0.042) | (0.032) | (0.021) | (0.027) |
| Real house price change | −0.0001 | 0.0002 | −0.0002 | 0.006 | 0.012 | 0.004 |
| | (0.0004) | (0.0004) | (0.0003) | (0.018) | (0.014) | (0.014) |
| Long-term interest rate | 0.083 | −0.011 | 0.112 | −0.238 | −0.782 ** | 0.126 |
| | (0.089) | (0.076) | (0.101) | (0.498) | (0.348) | (0.342) |
| Trade openness | 0.189 | 0.464 | 0.770 | −0.193 | 0.387 | 0.307 |
| | (0.313) | (0.354) | (0.532) | (0.196) | (0.334) | (0.361) |
| Income growth | −0.002 | −0.007 | −0.019 *** | 0.007 | −0.002 | −0.002 |
| | (0.004) | (0.005) | (0.005) | (0.010) | (0.009) | (0.007) |
| Capital account liberalization | 0.058 | −0.102 | 0.336 * | 0.100 | −0.198 ** | 0.286 * |
| | (0.116) | (0.109) | (0.188) | (0.157) | (0.097) | (0.155) |
| Credit market deregulation | −0.076 | −0.053 | 0.009 | −0.039 | −0.038 | 0.110 ** |
| | (0.081) | (0.090) | (0.045) | (0.115) | (0.119) | (0.048) |
| EMU membership | 0.115 | 0.356 ** | −0.075 | −0.017 | 0.274 | −0.388 ** |
| | (0.140) | (0.161) | (0.258) | (0.112) | (0.184) | (0.170) |
| Financial crisis | 0.075 | 0.199 | 0.009 | | | |
| | (0.125) | (0.124) | (0.123) | | | |
| VIX | 0.004 | −0.002 | −0.0001 | 0.004 | −0.005 | −0.005 |
| | (0.004) | (0.003) | (0.005) | (0.009) | (0.006) | (0.010) |
| Observations | 233 | 238 | 232 | 151 | 156 | 150 |
| Log-likelihood | −155.0 | −161.3 | −175.0 | −93.1 | −87.8 | −95.5 |
| R-squared | 0.10 | 0.11 | 0.12 | 0.15 | 0.12 | 0.14 |

*Notes:* The dependent variable is similarity of total credit, non-financial business credit, and household mortgage credit cycles. The Table reports coefficient estimates with robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Constant and country-fixed effects are included in the estimations (not shown).

The results for similarity of credit cycles are somewhat different (see Table 4). Here the coefficient estimate of the mortgage share in total credit is significant only in the pre-crisis period (although sensitivity checks indicate that it is significant for all years when excluding any one of the countries: Spain, Greece, or Estonia — see below). EMU membership widened differences in mortgage credit cycle amplitudes before the crisis, decreasing their similarity with EMU reference cycle, while

it made non-financial business credit cycles more similar in the period including crisis years. Net capital flows and real stock price changes decrease the differences in total credit cycle amplitudes, making cycles more similar.

Finally, we analyze similarity conditional on synchronicity of total-credit cycles. Because of few observations on negative synchronicity, we do this by including interaction terms of a synchronicity dummy with the mortgage share and capital account liberalization (our key variables of interest), so that we can use the whole sample.[7] The dummy takes the value 0 when synchronicity is below or equal to zero (cycles move in opposite directions to the EMU reference cycle), and 1 when synchronicity is above zero (cycles move in the same direction).

In Table 5, we find that a higher relative mortgage share in total credit is associated with *larger* similarity of the total-credit cycle when it was moving in sync with the EMU reference cycle, but only when including the crisis years. This is intuitive, as strongly synchronous mortgage cycles in the crisis years is an indicator for the collapse of growth in mortgage lending throughout the EMU. It is clear that this joint collapse increased similarity of credit cycles. Before the crisis, mortgage shares are negatively associated with similarity, but less strongly than in Table 4. When credit cycles are moving out of sync, mortgage share is significantly and negatively correlated with the similarity of total cycles in the pre-crisis period.

Interestingly, we observe that EMU membership is now associated with more total-credit cycle similarity when including the crisis years. In Table 4 we found no significant EMU coefficient for total-credit similarity. In Table 5, the coefficient estimate for 1990–2013 is more than twice the size of the Table 4 estimate, for 1990–2007 it is ten times larger (and positive) – although insignificant.

We also find that liberalization makes synchronous total-credit cycles less similar, significantly so for the pre-crisis period. We speculate that this negative association of similarity with capital account liberalization in synchronous credit cycles in

[7] We also estimated models with interaction terms for other explanatory variables, but those were found insignificant.

Table 5: **Similarity of synchronous total-credit cycles**

| | 1990–2013 | | 1990–2007 | |
|---|---|---|---|---|
| Mortgage share | −0.894 | −0.882 | −1.609 * | −1.593 * |
| | (0.631) | (0.640) | (0.808) | (0.814) |
| Synchronicity dummy | −0.235 | −0.055 | −0.131 | 0.316 |
| | (0.304) | (0.490) | (0.322) | (0.293) |
| Mortgage share×Synchronicity dummy | 0.631 * | 0.677 * | 0.479 | 0.534 |
| | (0.328) | (0.324) | (0.384) | (0.359) |
| Net capital flows | 0.002 | 0.002 | 0.003 * | 0.003 ** |
| | (0.002) | (0.001) | (0.001) | (0.001) |
| Real stock price change | 0.042 *** | 0.041 *** | 0.052 * | 0.048 |
| | (0.010) | (0.010) | (0.030) | (0.032) |
| Real house price change | −0.0001 | −0.0001 | 0.004 | 0.006 |
| | (0.0004) | (0.0004) | (0.020) | (0.020) |
| Long-term interest rate | 0.057 | 0.061 | −0.288 | −0.516 |
| | (0.070) | (0.074) | (0.472) | (0.482) |
| Trade openness | 0.083 | 0.091 | −0.370 | −0.367 |
| | (0.309) | (0.314) | (0.233) | (0.242) |
| Income growth | 0.001 | 0.001 | 0.010 | 0.010 |
| | (0.004) | (0.003) | (0.008) | (0.007) |
| Capital account liberalization | −0.061 | −0.021 | −0.033 | 0.024 |
| | (0.135) | (0.083) | (0.188) | (0.138) |
| CAL×Synchronicity dummy | | −0.100 | | −0.221 ** |
| | | (0.156) | | (0.105) |
| Credit market deregulation | −0.105 | −0.105 | −0.074 | −0.077 |
| | (0.077) | (0.078) | (0.109) | (0.109) |
| EMU membership | 0.239 * | 0.253 ** | 0.104 | 0.137 |
| | (0.115) | (0.110) | (0.101) | (0.086) |
| Financial crisis | 0.002 | 0.003 | | |
| | (0.094) | (0.095) | | |
| VIX | 0.004 | 0.004 | 0.004 | 0.005 |
| | (0.003) | (0.003) | (0.008) | (0.008) |
| Observations | 233 | 233 | 151 | 151 |
| Log-likelihood | −140.6 | −140.2 | −86.5 | −85.3 |
| Pseudo R-squared | 0.20 | 0.21 | 0.22 | 0.23 |

*Notes:* The dependent variable is similarity of the total-credit cycle. The Table reports coefficient estimates with robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. Constant and country-fixed effects are included in the estimations (not shown).

Table 5, was probably absorbed into the EMU membership variable in Table 4. Separating them out in Table 5 produces a positive association of EMU membership with total-credit cycle similarity. This suggests that capital account liberalization could be one of the channels through which EMU membership may have contributed to divergence of credit cycles across EMU states.

## 5.3 Sensitivity checks

We conducted an extensive sensitivity analysis to test the robustness of all results (available on request). First, to control for time fixed effects we included year dummies. Notably, the coefficient of mortgage share became smaller (in absolute value) in estimations for synchronicity, and significant for similarity during 1990–2013. EMU membership turned insignificant for synchronicity, probably because time dummies control for an effect of EMU years. The remaining results are comparable to the main ones. Since adding so many time dummies leads to a substantial loss of degrees of freedom and given that they are jointly insignificant, we choose to report the estimation results without them.

Second, we excluded real house price changes from the estimation. Changes in house prices could have an indirect effect on demand and supply of mortgages. Consequently, when including house prices and mortgages together, we might not be able to separate the impact of each of these variables. Moreover, the growth in house price variable is volatile and may distort results due to extreme values. We found that excluding house prices did not qualitatively influence the results.

Third, we re-defined three relative variables — real house price change, real stock price change, and income growth — as differences to the EMU median (instead of ratio), to reduce their volatility. The key results are not affected, although some controls become significant — higher stock price changes and lower income growth are associated with more synchronous total and business credit cycles.

Next, we re-defined synchronicity and similarity for country $i$ while excluding country $i$ from the computation of the EMU reference cycle, to avoid any bias by construction. To be consistent, we re-calculated domestic variables in relative terms; that is, $X_{it} = \frac{Z_{it}}{Z_{rt}}$, where $Z_{rt}$ is the median of this variable for all EMU countries in the sample excluding country $i$. This decreases the size of the estimate on mortgage share, but does not alter its significance. Moreover, EMU membership is robustly associated with larger similarity of synchronous total credit cycles, in both periods.

Other results are similar to main ones.

Alternatively, we included all domestic variables in non-relative terms. Mortgage share became insignificant in explaining synchronicity of credit cycles, but remained significant for similarity. Higher stock prices and interest rates and lower income growth are associated with more synchronous cycles. The outcomes for EMU membership and institutional factors are qualitatively similar to the main ones. Given that we measure coherence of credit cycles as compared to the EMU reference cycle, it is more sensible to measure domestic factors also as compared to EMU reference; the results are more robust for relative variables.

Further, we used gross instead of net capital inflows. While this results in significantly negative coefficients of capital flows with synchronicity and similarity of total cycles in 1990–2007 (with no change to other outcomes), we found that these changes are entirely driven by extreme values for Luxembourg.

Also, we control for cross-border financial exposure of countries, measured as the sum of total claims and liabilities (in % GDP) of domestic financial institutions abroad, from BIS consolidated banking statistics. This variable is available for 70% of observations in our sample. More foreign exposure leads to credit concentration in particular countries, which could make credit cycles less synchronized and less similar. The findings show that more cross-border exposure does not affect similarity, while it significantly reduces synchronicity of total and mortgage credit cycles in the pre-crisis period. Other results are not affected.

In this small sample, it is important to check whether some countries are driving the results. We excluded each country in turn. This did not change the sign and significance of most variables. The negative mortgage share coefficient remains robustly significant throughout. In estimations without Spain, Greece, or Estonia, the mortgage share becomes significant also for 1990–2013 in the models for similarity (Table 4) and for similarity conditional on synchronicity (Table 5).

Finally, we re-defined a financial crisis dummy as taking values 1 for 2008–2013

but also for 2000–2001, to account for the dot-com bubble crash. The results remain qualitatively unchanged, while the crisis dummy is insignificant.

# 6 Conclusion

Credit cycles and their cross-country coherence matter to a range of macroeconomic outcomes and to EMU monetary policy effectiveness. The dynamics of household mortgage credit and loans to non-financial business have diverged significantly in recent decades. Still, research on credit cycles is scant.

In this paper we construct and describe credit cycles for total bank credit, household mortgages and non-financial business loans for 14 EMU economies over 1990–2013. We explore their cross-country coherence in terms of similarity in amplitudes of credit gaps, and synchronicity of the direction of change in credit gaps. We also analyze correlates of credit cycle coherence.

Two findings stand out. As household mortgage credit assumes a larger share in total credit, this undermines credit cycle coherence across EMU economies. And EMU membership is associated with convergence of business credit cycles (in line with findings on convergence of business cycles) but *divergence* of household mortgage credit cycles — both in terms of similarity and synchronicity. Further exploration suggests that capital account liberalization could be one of the channels through which EMU membership may have contributed to declining similarity of credit cycles across EMU member-states. These findings survive a battery of sensitivity checks.

While these findings are new and potentially policy relevant, it is important to identify their limitations. Credit cycles can be constructed in many ways, depending on choice of turning points and filters. They are considerably longer than business cycles, so that the length of the sample may prevent observing the full cycle. Their differences from a financial cycle — including both credit and property prices (Borio, 2014) — must be borne in mind. Credit cycles are also endogenous to

most macroeconomic variables so that any causal analysis is challenging. And our theoretical understanding of the significance of credit cycles is still very limited.

That said, we surveyed recent trends and literature which indicate that credit cycles may have been neglected to our peril until recently. Early proponents such as Borio and Lowe (2004) argued for the importance of quantitative credit aggregates to understanding macroeconomic trends and policy effectiveness. A long-standing literature has argued that credit conditions matter (Bernanke and Gertler, 1995). This has been underscored by recent research on growth and differentiation of credit, and its link to long-term output growth, asset market developments, financial instability and severity of post-crisis recessions.

In this light, the present paper contains two messages for policy makers. First, the composition of credit matters to credit cycle coherence. We now know much about the dangers of excessive mortgage growth. This paper adds declining credit cycle coherence to this list of risks. Second, our results suggest that for many countries, EMU accession had unintended side effects: credit cycle de-synchronization and divergence in amplitudes relative to an EMU-median trend. The credit channel literature suggests that this makes for differences in impacts of the common monetary policy. Both these findings should be important in assessing monetary policy effectiveness.

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# Appendix

Table A.1: **Description of variables and their data sources**

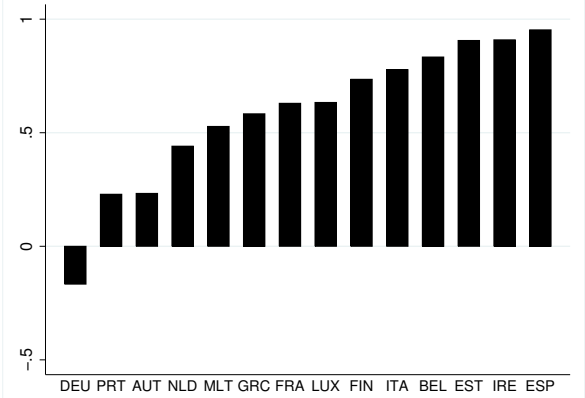
| Variable | Description | Data sources |
|---|---|---|
| Synchronicity, $\eta_i(t)$ | Calculated using formula (1) for total, non-financial business, and mortgage credit cycles | Central banks' statistics |
| Similarity, $\theta_i(t)$ | Calculated using formula (2) for total, non-financial business, and mortgage credit cycles | Central banks' statistics |
| Mortgage share | Share of household mortgage credit in total bank credit to private sector (in %) | Central banks' statistics |
| Net capital flows | Net financial account (gross inflows - gross outflows) in % of nominal GDP | IMF BoP Statistics, Eurostat |
| Real stock price change | Annual change (in %) in the stock market index (deflated by CPI) | OECD |
| Real house price change | Annual change (in %) in house price (deflated by CPI) | BIS |
| Long-term interest rate | Interest rate on 10-year government bonds | Datastream |
| Trade openness | Sum of export and import of goods and services as % of nominal GDP | IFS IMF |
| Income growth | Growth rate of GDP per capita (in 2005 USD) | WDI World Bank |
| Capital account liberalization | Chinn-Ito index of capital account openness. The index uses information on restrictions on cross-border financial transactions reported by the IMF Annual Report on Exchange Arrangements and Exchange Restrictions. The index takes values from -1.88 to 2.42 | Chinn and Ito (2008) |
| Credit market deregulation | Index consists of 3 components: ownership of banks (percentage of deposits held in privately owned banks), extension of credit (share of private sector credit in total bank credit), presence of interest rate controls/negative interest rates. The credit deregulation index is an average of the components. The index takes values from 1 to 10. | Fraser Institute's Economic Freedom Indicators |
| EMU membership | Dummy, 1 — a country is an EMU member in year $t$, 0 otherwise | Own construction |
| Financial crisis | Dummy, 1 — from 2008 onwards, 0 otherwise | Own construction |
| Global volatility | VIX index (Chicago Board Options Exchange Market Volatility Index) | BIS |

Table A.2: **Descriptive statistics**

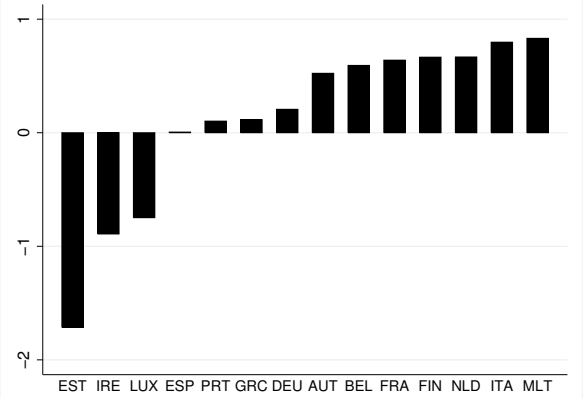
| Variable | No obs. | Mean | Sd | Min | Max |
|---|---|---|---|---|---|
| **Coherence measures** | | | | | |
| Synchronicity, total credit cycle | 266 | 0.54 | 0.77 | −1.00 | 1.00 |
| Synchronicity, non-fin. bus. credit cycle | 266 | 0.45 | 0.79 | −1.00 | 1.00 |
| Synchronicity, mortgage cycle | 260 | 0.39 | 0.85 | −1.00 | 1.00 |
| Similarity, total credit cycle | 266 | 0.18 | 0.89 | −3.38 | 1.00 |
| Similarity, non-fin. bus. credit cycle | 266 | 0.15 | 0.92 | −4.59 | 1.00 |
| Similarity, mortgage cycle | 260 | 0.16 | 0.75 | −2.35 | 1.00 |
| **Domestic factors, constructed as ratios to EMU median** | | | | | |
| Mortgage share | 261 | 1.00 | 0.29 | 0.25 | 1.65 |
| Net capital flows | 260 | 0.28 | 18.49 | −93.92 | 149.20 |
| Real stock price change | 265 | 1.17 | 2.58 | −4.65 | 32.15 |
| Real house price change | 248 | 1.10 | 111.29 | −759.47 | 940.22 |
| Long-term interest rate | 256 | 1.14 | 0.55 | 0.45 | 6.52 |
| Trade openness | 266 | 1.28 | 0.72 | 0.54 | 3.74 |
| Income growth | 266 | 1.46 | 4.96 | −20.96 | 43.56 |
| **Domestic institutional factors** | | | | | |
| Capital account liberalization | 266 | 2.11 | 0.86 | −1.18 | 2.42 |
| Credit market deregulation | 266 | 8.51 | 1.34 | 4.30 | 10.00 |
| **Event factors** | | | | | |
| EMU membership | 266 | 0.69 | 0.46 | 0.00 | 1.00 |
| Financial crisis | 266 | 0.32 | 0.47 | 0.00 | 1.00 |
| **Global factor** | | | | | |
| ViX index | 266 | 21.28 | 9.54 | 10.90 | 52.40 |

Figure A.1: Credit cycle synchronicity and similarity

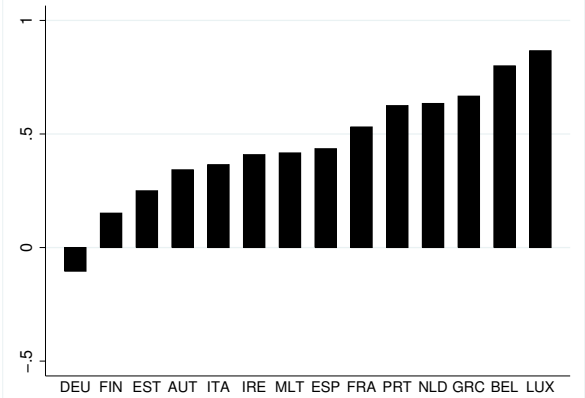
(a) Synchronicity, total credit cycle



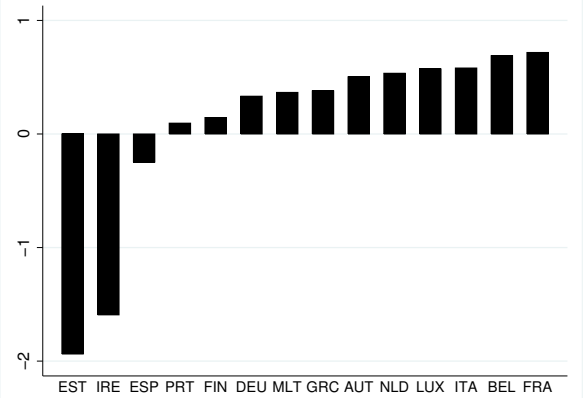

(b) Similarity, total credit cycle



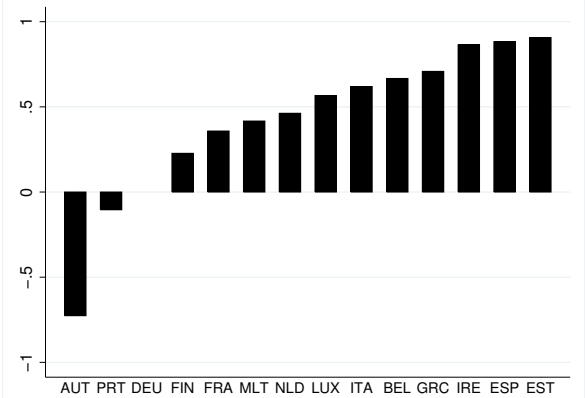

(c) Synchronicity, non-fin. business credit cycle



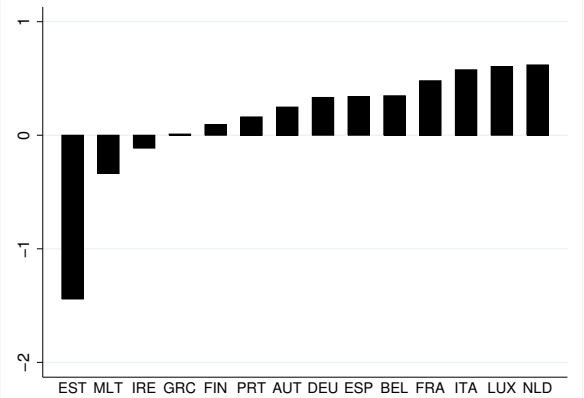

(d) Similarity, non-fin. business credit cycle




(e) Synchronicity, mortgage credit cycle




(f) Similarity, mortgage credit cycle



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